JANUARY 2013

Volume 20
Number 1

MSMR

MEDICAL SURVEILLANCE MONTHLY REPORT


James Gathany/CDC


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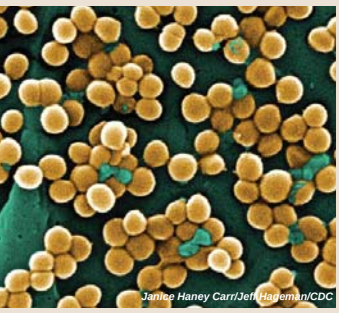
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Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JAN 2013		**00-00-2013 to 00-00-2013**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Medical Surveillance Monthly Report	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Medical Surveillance Montly Report (MSMR),Armed Forces Health Surveillance Center,11800 Tech Road, Suite 220 (MCAF-CS),Silver Spring,MD,20904**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**20**	

Update: Malaria, U.S. Armed Forces, 2012

U.S. service members are at risk of malaria when they are assigned to endemic areas (e.g., Korea), participate in operations in endemic areas (e.g., Afghanistan, Africa) and visit malarious areas during personal travel. In 2012, 38 service members were reported with malaria, fewer than in any of the past nine years. Nearly two-thirds of cases were presumably acquired in Afghanistan (n=24) and seven cases were considered acquired in Africa. The majority of cases were caused by *P. vivax* and nearly one-third were reported as "unspecified" malaria. Malaria was diagnosed/reported from 25 different medical facilities in the United States, Afghanistan, Kyrgyzstan, Germany, and Korea. The relatively low number of cases in 2012 reflects at least in part the drawdown of troops serving in Afghanistan. Providers of care to military members should be knowledgeable regarding and vigilant for clinical presentations of malaria outside of endemic areas.

Malaria is a serious, often life-threatening, mosquito-transmitted parasitic disease. Four *Plasmodium* species are responsible for the overwhelming majority of human malaria infections: *Plasmodium falciparum* (the most deadly), *P. vivax* (the most common), *P. ovale*, and *P. malariae*. Three other *Plasmodium* species that infect non-human primates have been found to occasionally cause malaria in humans. *P. knowlesi*, in particular, has been responsible for cases in Malaysia and elsewhere in Southeast Asia, but its contribution to the worldwide burden of malaria has been minor.

Malaria is endemic in more than 100 countries throughout the tropics and in some temperate regions. In 2010, malaria accounted for 219 million illnesses and an estimated 660,000 deaths worldwide; most deaths were due to *P. falciparum* infections of young children in Africa.[1] International efforts to control malaria are working; many countries have reported reductions in the numbers of malaria cases and deaths due to malaria during the past decade.[2]

For centuries, malaria has been recognized as a disease of military operational significance.[3,4] U.S. service members are at risk of malaria when they are permanently assigned to endemic areas (such as near the Demilitarized Zone [DMZ] in Korea);[5,6] when they participate in operations in endemic areas (e.g., Afghanistan,[7] Africa,[8] Haiti[9]); and when they visit malarious areas during personal travel. The U.S. military has effective countermeasures against malaria, including chemoprophylactic drugs, permethrin-impregnated uniforms and bed nets, and DEET-containing insect repellents. When cases and outbreaks of malaria do occur, they are generally due to non-compliance with indicated chemoprophylactic or personal protective measures.

In the 1990s, there was a general increase in malaria incidence among U.S. service members, primarily due to *P. vivax* infections acquired near the DMZ in Korea.[5,6,10-12] Since 2001, U.S. service members have been exposed to malaria risk due predominately to *P. vivax* while serving in Southwest and Central Asia (particularly in Afghanistan).[7] Service members who conduct civil-military and crisis response operations in Africa are at risk of malaria primarily due to *P. falciparum*;[8] the number at risk may have increased since the establishment of the U.S. Africa Command (AFRICOM) in 2007. In 2010, several thousand U.S. military members risked exposure to *P. falciparum* while conducting an earthquake disaster response mission in Haiti.[9] This report summarizes the malaria experiences of U.S. service members during calendar year 2012 and compares it to recent experience.

METHODS

The surveillance period was January 2004 through December 2012. The surveillance population included active and reserve component members of the U.S. Armed Forces. The Defense Medical Surveillance System was searched to identify reportable medical events and hospitalizations (in military and non-military facilities) that included diagnoses of malaria (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] code: 084). A case of malaria was defined as an individual with (1) a reportable medical event record of confirmed malaria; (2) a hospitalization record with a primary (first-listed) diagnosis of malaria; (3) a hospitalization record with a non-primary diagnosis of malaria due to a specific *Plasmodium* species (ICD-9-CM: 084.0-084.3); (4) a hospitalization record with a non-primary diagnosis of malaria plus a diagnosis of anemia (ICD-9-CM: 280-285), thrombocytopenia and related conditions (ICD-9-CM: 287), or malaria complicating pregnancy (ICD-9-CM: 647.4) in any diagnostic position; or (5) a hospitalization record with a non-primary diagnosis of malaria plus diagnoses of signs or symptoms consistent with malaria (as listed in the Control of Communicable Diseases Manual, 18th Edition)[13] in each diagnostic position antecedent to malaria. Malaria diagnoses during outpatient encounters alone (i.e., not hospitalized or reported as a notifiable event) were not considered case-defining for this analysis.

This summary allowed one episode of malaria per service member per 365-day period. When multiple records documented a single episode, the date of the earliest encounter was considered the date of clinical onset, and the most specific diagnosis was used to classify the *Plasmodium* species.

Presumed locations of malaria acquisition were estimated using a hierarchical classification algorithm: (1) cases hospitalized in a malarious country were

FIGURE 1. Malaria cases among U.S. service members, by *Plasmodium* species and calendar year of diagnosis/report, 2004-2012

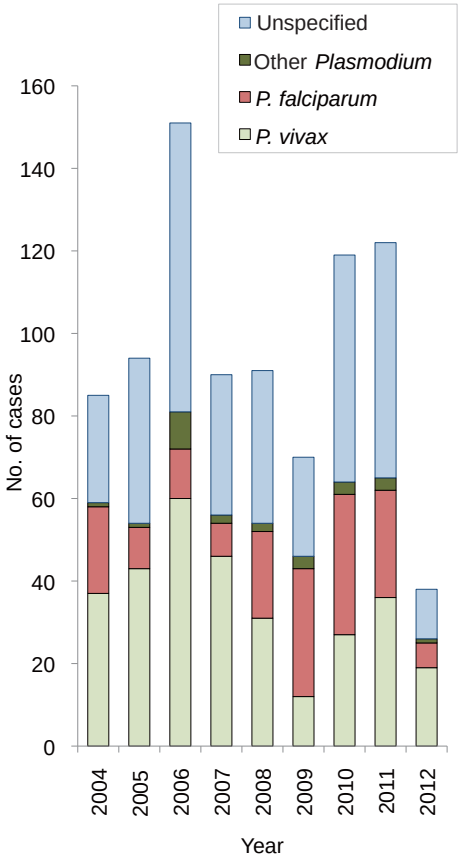


TABLE 1. Malaria cases by *Plasmodium* species and selected demographic characteristics, U.S. Armed Forces, 2012

	P. vivax	*P. falciparum*	Unspecified or other	Total	% of total
Total	19	6	13	38	100.0
Component					
Active	19	6	10	35	92.1
Reserve/Guard	0	0	3	3	7.9
Service					
Army	17	3	11	31	81.6
Navy	0	1	1	2	5.3
Air Force	1	1	0	2	5.3
Marine Corps	1	1	1	3	7.9
Gender					
Male	18	6	11	35	92.1
Female	1	0	2	3	7.9
Age group					
<20	0	0	0	0	0.0
20-24	10	0	2	12	31.6
25-29	6	3	5	14	36.8
30-34	2	2	1	5	13.2
35-39	1	0	3	4	10.5
40+	0	1	2	3	7.9
Race/ethnicity					
White, non-Hispanic	13	0	9	22	57.9
Black, non-Hispanic	1	5	0	6	15.8
Other	5	1	4	10	26.3

considered acquired in that country; (2) case reports (submitted as reportable medical events) that listed exposures to malaria endemic locations were considered acquired in those locations; (3) cases diagnosed among service members during or within 30 days of deployment or assignment to a malarious country were considered acquired in that country; (4) cases diagnosed among service members who had been deployed to Afghanistan or Korea within two years prior to diagnosis were considered acquired in those countries; (5) all remaining cases were considered acquired in unknown locations.

RESULTS

In 2012, 38 U.S. military members were diagnosed and/or reported with malaria. The number of malaria cases in 2012 was by far the lowest of the past nine years **(Figure 1)**. Half of the 2012 cases were caused by *P. vivax* (n=19, 50%) and approximately 16 percent by *P. falciparum* (n=6) **(Table 1).** The responsible agent was "unspecified" for approximately one-third (n=13) of 2012 cases. In 2012, as in prior years, most U.S. military members diagnosed with malaria were male (92%), active component members (92%), in the Army (82%), of "white" race/ethnicity (58%) and in their 20s (69%) **(Table 1)**.

Of the 38 malaria cases in 2012, nearly two-thirds of the infections were considered to have been acquired in Afghanistan (n=24, 63%) and approximately 18 percent in Africa (n=7); three infections (8%) were presumably acquired in Korea and one in Honduras **(Table 2)**. The remaining three malaria cases had unknown areas of infection acquisition. Of the seven malaria infections considered acquired in Africa, three were likely acquired in Ghana, one each in Togo and Liberia, and two among service members recently assigned to Djibouti **(data not shown)**.

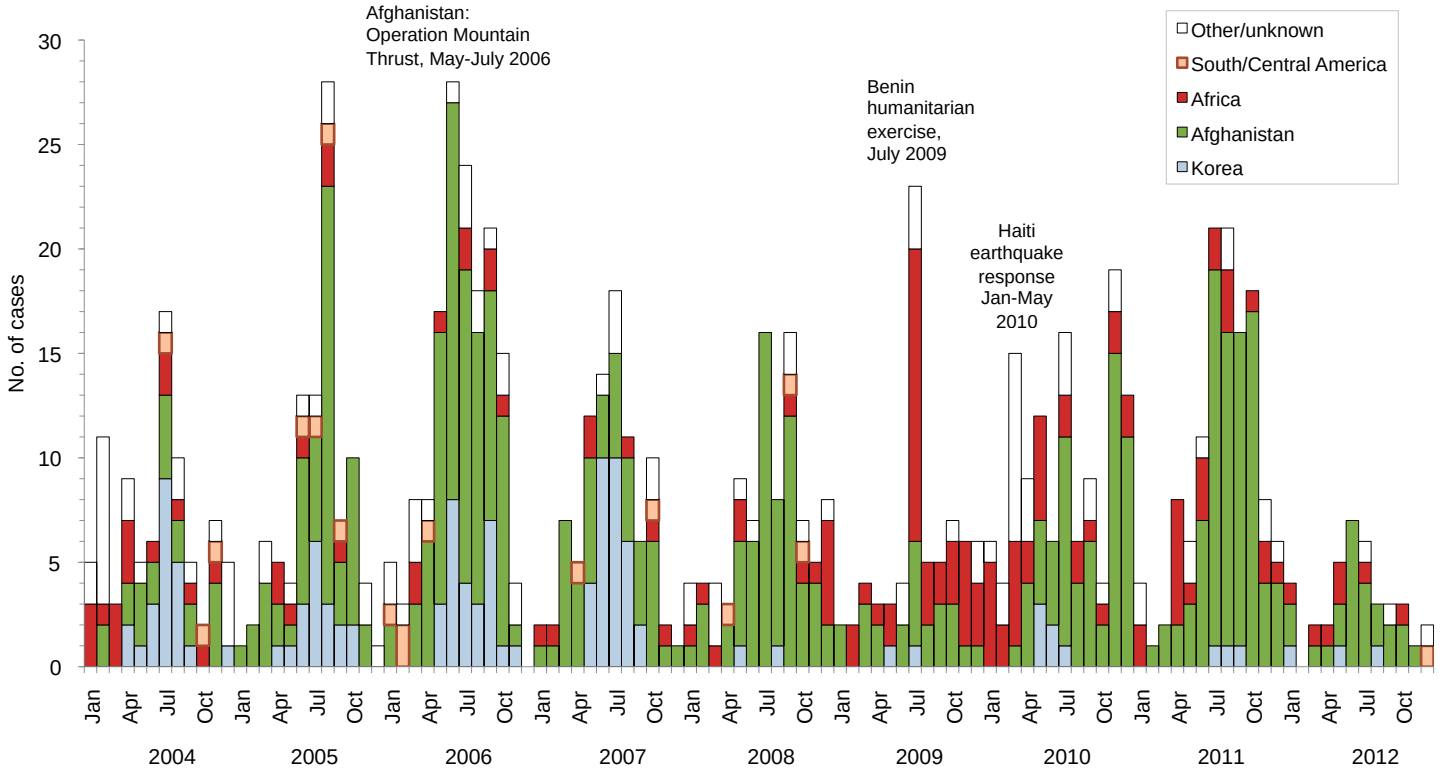
The number of Afghanistan-acquired malaria cases in 2012 (n=24) was lower than in six of the eight prior years **(Figure 2)**. The number of Africa-acquired cases (n=7) was similar to the annual numbers of cases from 2005 through 2007 (range: 7-8 cases), but lower than the numbers in more recent years. The number of malaria cases acquired in Korea in 2012 (n=3) was similar to the numbers in recent prior years (range, 2008-2011: 2-6 cases). The single Honduras-acquired case was the first since 2008.

During 2012, malaria cases were diagnosed in or reported from 25 different medical facilities in the United States, Afghanistan, Kyrgyzstan, Germany, and Korea. More than one-quarter of cases (n=11, 29%) were reported from or diagnosed outside the United States **(Table 2)**. Five cases were reported from U.S. military

TABLE 2. Number of malaria cases by geographical locations of diagnosis or report and presumed location of acquisition, U.S. Armed Forces, 2012

	Presumed location of acquisition						
Location of diagnosis/report	Afghanistan	Africa	Korea	South/Central America	Unknown	Total	% of total
Fort Shafter, HI	6	.	.	.	.	6	15.8
Fort Knox, KY	4	.	.	.	1	5	13.2
Fort Bragg, NC	1	1	1	.	.	3	7.9
Fort Campbell, KY	2	.	.	.	.	2	5.3
Bagram/Camp Lacy, Afghanistan	2	.	.	.	.	2	5.3
Camp Salerno, Afghanistan	1	.	.	.	.	1	2.6
Jalalabad, Afghanistan	1	.	.	.	.	1	2.6
Manas, Kyrgyzstan	1	.	.	.	.	1	2.6
Landstuhl, Germany	1	.	.	.	.	1	2.6
Grafenwoehr, Germany	1	.	.	.	.	1	2.6
Elmendorf-Richardon AFB, AK	1	.	.	.	.	1	2.6
Little Rock AFB, AR	1	.	.	.	.	1	2.6
Schofield Barracks, HI	1	.	.	.	.	1	2.6
Bethesda, MD	.	1	.	.	.	1	2.6
Jacksonville, FL	.	1	.	.	.	1	2.6
Fort Leonard Wood, MO	.	1	.	.	.	1	2.6
Fort Bliss, TX	.	1	.	.	.	1	2.6
Portsmouth, VA	.	1	.	.	.	1	2.6
Seoul, Korea	.	.	1	.	.	1	2.6
Camp Casey, Korea	.	.	1	.	.	1	2.6
Camp Pendleton, CA	.	.	.	.	1	1	2.6
Unknown hospital, Europe	.	.	.	.	1	1	2.6
Unknown hospital, Latin America	.	.	.	1	.	1	2.6
Location not reported	1	1	.	.	.	2	5.3
Total (% of total)	24 (63%)	7 (18%)	3 (8%)	1 (3%)	3 (8%)	38 (100%)	

FIGURE 2. Malaria among U.S. service members, by estimated location of infection acquisition, 2004-2012



facilities in Afghanistan and Kyrgyzstan and single cases were diagnosed in civilian hospitals in Europe and Latin America (countries not reported). The largest numbers of malaria cases during the year were treated at/reported from Fort Shafter, HI (n=6) and Fort Knox, KY (n=5).

In 2012, as in recent prior years, most malaria cases among U.S. military members were diagnosed from May through October **(Figure 2)**. The finding reflects the relatively high proportion of cases acquired in temperate Afghanistan as compared to tropical regions of Africa and Haiti.

EDITORIAL COMMENT

In 2012, there were fewer cases of malaria diagnosed/reported among U.S. military members than in any of the previous eight years. The report documents relatively low but continuing acquisition of malaria among U.S. military members in Afghanistan and Africa. Malaria acquisitions in Korea remained low; since 2008, there have been six or fewer Korea-acquired cases among U.S. military members each year.

Numerous factors could contribute to year-to-year changes in numbers of malaria cases. For example, the number of U.S. military members serving in malaria-endemic countries is not constant; and of particular note, there were 29 percent fewer U.S. military personnel in Afghanistan on 30 September of 2012 versus 2011 (source: Defense Manpower Data Center). Annual changes in environmental variables (e.g., severe winters, dry summers) may decrease the ranges and numbers of mosquitoes capable of transmitting malaria. In Afghanistan, irrigation and temperature (but not precipitation) are significant predictors of malaria transmission.[14]

There are significant limitations to this report that should be considered when interpreting the findings. For example, the ascertainment of malaria cases is likely incomplete; some cases treated in deployed or non-U.S. military medical facilities may not have been reported or otherwise ascertained. Only malaria infections that resulted in hospitalizations in fixed facilities or were reported as notifiable medical events were considered cases for this report. Infections that were treated only in outpatient settings and not reported as notifiable events were not included as cases. Also, the locations of infection acquisitions were estimated from reported relevant information. Some cases had reported exposures in multiple malarious areas, and others had no relevant exposure information. Personal travel to or military activities in malaria-endemic countries were not accounted for unless specified in notifiable event reports. Persons born in malaria-endemic regions have been found to be over-represented among the cases of malaria in U.S. service members. A recent report estimated that the malaria rate was 44 times higher in service members born in western Africa than among those born in the United States.[15]

As in prior years, in 2012, most malaria cases among U.S. military members were treated at medical facilities remote from malaria endemic areas; of note, 25 medical facilities treated any cases, and 20 facilities treated only one case each during the past year. Providers of acute medical care to service members (in both garrison and deployed settings) should be knowledgeable of and vigilant for the early clinical manifestations of malaria – particularly among service members who are currently or were recently in malaria-endemic areas (e.g., Afghanistan, Africa, Korea).

Care providers should be capable of diagnosing malaria (or have access to a clinical laboratory that is proficient in malaria diagnosis) and initiating treatment (particularly when *P. falciparum* malaria is clinically suspected). Continued emphasis on standard malaria prevention protocols is warranted; all military members at risk of malaria should be informed in detail of the nature and severity of the risk; they should be trained, equipped, and supplied to conduct all indicated countermeasures; and they should be closely monitored to ensure compliance. Personal protective measures against malaria include the proper wear of permethrin impregnated uniforms; the use of bed nets and military issued DEET-containing insect repellent; and compliance with prescribed chemoprophylactic drugs before, during, and after times of exposure in malarious areas.

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Confirmed Malaria Cases among Active Component U.S. Army Personnel, January-September 2012

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Of 26 cases of malaria reported among active component U.S. Army personnel during January through September 2012, 16 were laboratory-confirmed according to electronic medical records. Medical records and responses on post-deployment health assessment questionnaires were used to assess demographic and clinical characteristics, adherence to malaria prevention measures, and compliance with prescriptions for chemoprophylaxis. All but two cases were confirmed by peripheral blood smears. Twelve cases were caused by *Plasmodium vivax*, one by *P. falciparum*, and three unspecified diagnoses were deemed likely to be due to *P. vivax*. Fourteen cases were associated with deployment to Afghanistan. Adherence to Army malaria prevention measures during deployment and compliance with post-deployment primaquine chemprophylaxis were poor. Prescribed doses of primaquine often varied from current clinical or Department of Defense policy guidelines. Continued education, training and reinforcement of malaria prevention by medical and preventive medicine personnel are indicated, as is blood smear confirmation of suspected malaria cases. Unit commanders and supervisors play a crucial role in ensuring soldiers' adherence to malaria prevention measures.

Malaria has historically had a great impact on U.S. military operations and continues to threaten the health of service members in endemic regions of the world, despite being a largely preventable disease.[1-5] The annual malaria update in the Medical Surveillance Monthly Report *(MSMR)* documents malaria cases among active and reserve members of the U.S. Armed Forces identified through military notifiable disease reporting systems and electronic inpatient records. The January 2012 *MSMR* reported 124 cases of malaria among active duty military during 2011, including 99 cases among Army personnel.[6] The number of cases acquired in Afghanistan (n=91) in 2011 was the highest during the nine-year surveillance period. In June 2012, the U.S. Army Public Health Command (PHC) received a report from Fort Knox, Kentucky of a potential outbreak of *P. vivax* malaria among soldiers who had redeployed from Afghanistan in December 2011. The surveillance efforts described in the present report were undertaken to characterize the Fort Knox cases as well as all other confirmed malaria cases occuring among active component U.S. Army personnel from January through September 2012. The objective was to develop information that can be used to evaluate the effectiveness of malaria prevention programs, improve program implementation, and develop additional preventive interventions.

METHODS

The surveillance population was restricted to active component Army personnel with a confirmed malaria diagnosis and symptom onset during January through September 2012. Cases were identified from notifiable medical events reported to the PHC and to Task Force Medical-Afghanistan clinical operations. Malaria is one of 66 diseases or events for which the Department of Defense requires prompt electronic reporting because each occurrence is of public health or military operational importance.[7] A case was defined as an individual whose malaria diagnosis had been confirmed by at least one of several diagnostic tests including blood smear, rapid diagnostic test (RDT), and/or polymerase chain reaction (PCR). Reported cases were confirmed through review of electronic health records contained in the Armed Forces Health Longitudinal Technology Application (AHLTA), which documents outpatient diagnoses and treatments in deployed and garrison environments. Cases with peripheral blood smears initially read as positive by local laboratories but later found to be negative by expert reference laboratory analyses were considered unconfirmed. Confirmed cases were further investigated using a standardized cohort abstraction form to collect demographics, clinical data and information about adherence to prescribed medications and use of other preventive measures. The following Army-directed malaria preventive measures were assessed: insect repellant N,N-Diethyl-meta-toluamide (DEET), permethrin-treated uniforms, daily primary chemoprophylaxis, and terminal chemoprophylaxis.[7] Data were abstracted from the Post Deployment Health Assessment (PDHA) and medical records. Medical record data were considered more accurate than PDHA data when discrepancies occurred. For instance, if a patient reported full compliance with malaria chemoprophylaxis on the PDHA, but the patient's medical record documented incomplete chemoprophylaxis, the information in the medical record was used for analysis.

RESULTS

Cluster of cases in a redeployed unit, Fort Knox, KY

In June 2012, after two vivax malaria cases had been diagnosed among members of a unit that had redeployed in December 2011 from Afghanistan to Fort Knox, Kentucky, the unit medical officer advised the chain of command to refer for medical evaluation any soldiers with symptoms suggestive of malaria. In response, eight soldiers were referred for evaluations; of these, seven had non-specific symptoms and malaria was eventually ruled out. Hence, only one other case of malaria (for a total of three) was confirmed. Delays in diagnosing the malaria cases at Fort Knox were attributed to the laboratory's lack of access to RDTs and limited experience with diagnosing malaria by peripheral blood smears. Specimens were sent to the Centers for Disease Control and Prevention (CDC) for confirmation.

In response to diagnoses of multiple malaria cases in a single unit, all other members of the unit who were not glucose-6-phosphate dehydrogenase (G6PD) deficient were re-administered presumptive anti-relapse therapy (PART) with primaquine, since post-deployment adherence to PART had been poor. The third patient diagnosed with malaria had been non-adherent with PART.

Active component, U.S. Army

Of 26 reported cases of malaria among active component U.S. Army personnel from January through September 2012, 16 (62%) were laboratory-confirmed according to medical records. Fourteen (88%) were confirmed by peripheral blood smears, three by RDT, and two by PCR. Of the 16 confirmed cases, 12 (75%) were due to *Plasmodium vivax* species, three (19%) were characterized as unspecified in etiology but likely due to *P. vivax*, and one (6%) was attributed to *P. falciparum*. All confirmed cases occurred in enlisted males with an average age of 28 years (range: 20-42 years).

Twelve (75%) of the confirmed cases had returned from Afghanistan within nine months prior to diagnosis and two were diagnosed while still deployed in Afghanistan. Of the remaining two, one had recently traveled to Africa and the other was stationed in Korea and had recently completed a field exercise near the demilitarized zone (DMZ). Of the 14 deployment-related cases from Afghanistan, 9 had been deployed to Regional Command (RC) East, three to RC South, one to RC North, and one to an unknown location. The average length of deployment was 11 months (range: 5-12 months). The average time from redeployment to diagnosis was 5 months (range: 1-9 months).

Medical facilities at eight different locations diagnosed and treated the 16 confirmed cases. The locations and numbers of cases treated were as follows: Tripler Army Medical Center, HI: 6; Fort Knox: 3; Afghanistan: 2; and one each from Grafenwoehr, Germany, Fort Leonard Wood, MO, Yongsan, Korea, Fort Bragg, NC, and Fort Campbell, KY. The distribution of cases occurring by month was January: 2, March: 1, April: 2, June: 4, July: 3, August: 2, and September: 2.

Fifteen (94%) of the confirmed cases had been prescribed primary chemoprophylaxis according to medical records. The case with no record of having received chemoprophylaxis was stationed in Korea. All initial prescriptions for primary chemoprophylaxis were for doxycycline; one case was later switched to mefloquine due to gastrointestinal side effects.

PDHA data pertaining to chemoprophylaxis compliance and other malaria prevention measures were available for 14 of the 16 cases; all 14 reported non-adherence to at least one of the Army-directed preventive measures **(Table)**.[8]

Of the 16 confirmed cases, nine received prescriptions for PART; of these, five were for 30 mg tablets and four were for 15 mg tablets of primaquine base. Five of the nine had data available on adherence to therapy; only one reported full compliance with the two-week regimen of one dose per day. Fourteen had records indicating G6PD deficiency testing prior to deployment; all had normal G6PD levels.

Of the 15 malaria cases likely due to *P. vivax*, all were prescribed primaquine for anti-relapse therapy (ART) after diagnosis. Ten (67%) of the prescriptions were for 30 mg, three for 15 mg, one for 60 mg, and one for an unknown dose of primaquine base. Of the five cases for whom adherence was assessed, all reported full compliance.

TABLE. Adherence to preventive measures among confirmed cases of malaria, active component, U.S. Army, January 2012-September 2012

	No. adherent	% adherent
1. Use of DEET[a] insect repellant (n=14)	5	36
2. Daily use (wear) of permethrin treated uniform (n=14)	10	71
3. Daily adherence to chemoprophylaxis[b] (n=15)	7	47
4. Documented prescription for PART[c] (n=14)	9	64
5. Documented compliance with PART[d] (n=5)	1	20
Adherence to combinations of 1-4 (n=14)		
All four	0	0
Three	4	29
Two	9	64
One	1	7

[a]DEET, N,N-Diethyl-meta-toluamide; DEET use is recommended daily; however, patients indicating they used it at least sometimes were considered compliant.

[b]All patients except one (assigned to Korea) were prescribed doxycycline. One patient switched to mefloquine due to gastrointestinal side effects.

[c]PART, Presumptive anti-relapse therapy

[d]Records to evaluate compliance with PART were available for only five soldiers.

EDITORIAL COMMENT

This report summarizes findings of a study of 16 cases of malaria among active component members of the U.S. Army that were diagnosed during the first nine months of 2012. All but two of the cases were associated with deployment to Afghanistan. Among the deployment-related cases, adherence to Army-directed malaria preventive measures during deployment was poor.

Compared to the 99 cases of malaria that the *MSMR* reported among active and reserve component U.S. Army members in 2011, the total of 16 cases found among active component soldiers from January to September 2012 is surprisingly low.[6] Increased attention to malaria prevention and a drawdown of forces may explain some of this difference. Other factors that may have contributed to an apparent decline in cases are the inclusion of only active component soldiers in this study, a more specific malaria case definition, delays in reporting of cases, and a decline in malaria risk due to variations in vector populations and climatic conditions.[9] An important caveat to this study's estimate of malaria cases is that many possible cases occurring in Afghanistan are treated presumptively, with or without confirmation by RDT. Thus, the reported cases probably underestimate the true disease burden, particularly in the deployed setting. Other limitations of this study include the relatively small number of confirmed malaria cases as well as the potential for information bias in relying on exposure data from the PDHA and other administrative data. The results from this report may not be generalizable to the U.S. military population in other years or to populations outside the military.

After cases' return from their respective deployments, PART was given to only 64 percent of them; among those who received PART, adherence was poor. In 2004 the CDC recommended an off-label dose increase to 30 mg of primaquine per day based on evidence that *P. vivax* malaria relapse was still common at 15 mg per day. However, federal law prohibits off-label uses of medications administered to U.S. military service members for Force Health Protection purposes, including mass prescriptions for PART to entire units after deployment.[10] The 15 mg primaquine dose is theater policy because this is the dose approved by the Food and Drug Administration. However, off-label use by providers is permitted in routine clinical care. A daily dose of 30mg primaquine base for ART for confirmed *P. vivax* cases should be used instead of the 15 mg PART dose used for Force Health Protection.

Unit health care providers and preventive medicine personnel should be aware of chemoprophylaxis policies and assure that proper administration occurs in predeployment, deployment, post-deployment, and clinical settings. Although medical personnel are key to defining and prescribing the main elements of malaria (and other disease) prevention, in the deployment setting unit commanders and supervisors have the primary responsibility to ensure that soldiers at all levels of their commands take those actions necessary to protect the health of the force. Unit leaders must ensure, on a day-to-day basis, that each soldier adheres to the prescribed preventive measures with respect to DEET, permethrin-treated uniforms, daily prophylaxis, and eventually, PART.

The response to the first two cases of malaria identified at Fort Knox illustrates how good clinical care resulted in timely diagnoses of malaria which sparked a broader public health response. The recognition that other personnel from the affected unit may have been at risk prompted active case finding and unit surveillance. The decision to re-treat the entire unit with PART was based on a clinical and public health assessment of the risk and benefits of the therapy in that population.

A clinical diagnosis of malaria should be confirmed by RDT or blood smear microscopy whenever possible. The RDT is a particularly useful diagnostic tool that can rapidly distinguish between the potentially fatal *P. falciparum* and other forms of malaria. Ready availability of RDT or expertise in blood smear microscopy may have expedited the confirmation of the suspected malaria cases at Fort Knox and prevented unnecessary treatment. In the course of special public health investigations like that at Fort Knox, local, regional, and central preventive medicine assets can assist with many of the required public health management steps, including unit risk communication and prophylaxis, clinical care and case finding, disease reporting and surveillance, and arranging further laboratory testing.

Full compliance with Army-directed preventive methods[8] may have prevented some or many of the 16 cases reported here. This report expands earlier reports[1,3,4] with data on provider prescriptions for and soldier adherence to PART at times of redeployment and ART after diagnosis with *P. vivax*. Although deploying soldiers were all prescribed primary prophylaxis with doxycycline during deployment as per theater policy,[8] PART was inconsistently prescribed and more than half of cases were prescribed 30 mg primaquine base after return from deployment, even though 15 mg primaquine base is the theater policy. After diagnosis of vivax malaria, all cases were given ART, but only two-thirds had prescriptions for the standard dose of 30 mg primaquine base in clinical practice. Given this study's finding of varied primaquine doses for both PART and ART, increased attention may be warranted towards educating providers about the differences between routine post-deployment PART chemoprophylaxis and ART for clinical cases of vivax malaria.

This report suggests that the number of malaria cases in the U.S. Army decreased in 2012, compared to 2011. Although such a decline may have been the result of increased malaria control efforts, military medical and public health personnel and unit commanders and leaders should continue to reinforce the implementation of such efforts. Emphasis should be placed on awareness of current practices in malaria diagnosis and treatment; attention to chemoprophylaxis and the use of DEET and permethrin; and malaria reporting, surveillance, and outbreak investigation. Interventions which may reduce the incidence of malaria further include increased emphasis on PART with primaquine at

time of redeployment from Afghanistan and the preferred use of RDT as an initial diagnostic test at local levels.

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Acknowledgements: The authors thank LTC Rebekah J. Sarsfield, MAJ Elizabeth Adams, CPT Craig Meggitt, and Lea Anne Young Johnson, BS for their assistance in the investigation of the Fort Knox malaria cases.

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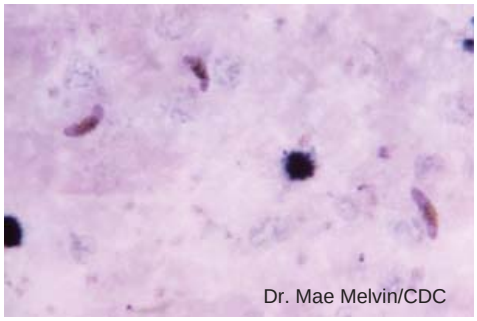
Notice to readers:

Solicitation of manuscripts for women's health issue

The *MSMR* is peer-reviewed and indexed in PubMed. The *MSMR* invites prospective authors to submit by 31 August 2013 manuscripts to be considered for an upcoming issue dedicated to women's health. Suitable reports include surveillance summaries, case series (either of broad scope or in specific military populations, subgroups, or settings) and historical snapshots. Descriptions of article types and instructions for authors are available at: http://www.afhsc.mil/msmr

Editorial: Presumptive Anti-Relapse Treatment for Malaria in Military Forces

Mark M. Fukuda, MD (COL, USA), Alan Magill, MD (COL, USA, Ret.)


Dr. Mae Melvin/CDC

In this issue of the *MSMR*, both the annual malaria update (page 2) and the report by Shaha and colleagues (page 6) document a decline in the number of malaria cases among U.S. service members in 2012 as compared to recent years. Most cases occurred in service members deployed to or recently returned from Afghanistan. The reasons for the observed decrease are very likely to be multifactorial, as discussed in both articles.

The article by Shaha et al. documents the frequency of inadequate compliance with chemoprophylaxis (and other preventive measures) among soldiers who developed malaria. The design of the study did not permit an assessment of chemoprophylaxis compliance among those who served in malaria-endemic regions but never got malaria. However, a recent survey of 528 military service members in Afghanistan found only 60 percent of respondents to be compliant with chemoprophylaxis regimens; reasons for noncompliance included gastrointestinal side effects (90% of service members were taking doxycycline), forgetfulness, and low perception of risk.[1]

Discussions of chemoprophylaxis compliance often focus on primary prophylaxis, in which blood schizonticide agents such as doxycycline kill all *Plasmodium* species exiting the liver during the time that clinical symptoms would have developed. Such agents, however, do not prevent the formation of hypnozoites which may later relapse. In settings such as Afghanistan, where relapsing *P. vivax* constitutes a large proportion of cases, ineffective presumptive anti-relapse treatment (PART) can increase malaria risk. Shaha et al. found that twelve of 14 (86%) deployers with malaria were diagnosed *after* return from Afghanistan; over the subsequent nine months, the average time from redeployment to diagnosis was five months. The *MSMR*'s malaria update also documents that most cases of Afghanistan-acquired malaria were initially treated in or reported from military treatment facilities in the United States. These data shed light on what may be an underappreciated role of PART relative to primary chemoprophylaxis.

A concerning aspect of Shaha's article is the fact that PART was administered to only 64 percent of respondents, and of those whose records allowed evaluation of PART, only one in five was compliant. The poor compliance with PART is not surprising since it is often prescribed hastily, during a period when shifting work patterns associated with redeployment and post-deployment leave may distract service members from complying with a full 14-day course of primaquine.


Dr. Mae Melvin/CDC

Shaha discusses the disparity between the primaquine dose for PART as recommended by the US FDA (15 mg) versus the 30 mg off-label dose recommended by the Centers for Disease Control and Prevention. These different recommendations and the subsequent conflicting interpretations of various Department of Defense Directives have led to confusion among practitioners and policy makers. How can practitioners provide the best guidance to military commanders about force health protection chemoprophylaxis within the constraints of federal law? Given the valuable insight provided by Shaha and colleagues, military commanders and health care providers should focus on getting PART, at either dose, to, and into service members as they return home.

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Images in Health Surveillance: Permethrin Treatment of Uniforms

Crew members prepare uniforms to be sprayed with permethrin on the flight deck aboard the Military Sealift Command (MSC) hospital ship USNS Mercy. In August 2010, the U.S. Army began issuing combat uniforms that are factory-treated with permethrin and designed to provide 70 percent protection from insect bites for up to 50 washes. The factory-impregnated Army combat uniforms are issued only to deployers but are expected to become standard issue in 2013. The U.S. Marine Corps has issued factory-produced permethrin-treated combat uniforms since 2007, and cadets at the U.S. Military Academy at West Point have been wearing them since 2002.

Uniforms are sprayed with permethrin at Marine Corps Base Camp Lejeune, NC. As compared to wearers of such field-treated uniforms, wearers of factory-treated uniforms have lower skin exposures to permethrin due to factory methods of binding permethrin to fabric.

Staphylococcus aureus and Other Skin and Soft Tissue Infections Among Basic Military Trainees, Lackland Air Force Base, Texas, 2008-2012

Bryant J. Webber, MD (Capt, USAF); Susan P. Federinko, MD, MPH (Lt Col, USAF); Juste N. Tchandja, PhD, MPH; Thomas L. Cropper, DVM, MPVM, DACVPM (Col, USAF, Ret.); Patrick L. Keller, MD, MPH (Maj, USAF)

Military training environments have been identified as high-risk settings for acquisition of skin and soft tissue infections (SSTIs), including those caused by methicillin-resistant *Staphylococcus aureus* (MRSA). Among the 148,355 basic military trainees at Lackland Air Force Base, Texas, between 1 October 2008 and 30 September 2012, there were 289 SSTIs, including 48 cases of culture-confirmed MRSA and 48 cases of possible MRSA – defined as SSTIs treated with both incision and drainage and MRSA drug coverage (i.e., trimethoprim-sulfamethoxazole, clindamycin, a tetracycline, or linezolid). The period prevalence rates of all SSTIs and MRSA SSTIs increased annually since fiscal year 2010. Of the 87 SSTIs cultured during the surveillance period, 74 were positive: MRSA (n=48); methicillin-sensitive *Staphylococcus aureus* (n=24); *Haemophilus parainfluenzae* (n=1); and viridans *Streptococcus* (n=1). Among MRSA positive cultures, three were resistant to clindamycin, one to tetracycline, and one to both clindamycin and tetracycline; none was resistant to trimethoprim-sulfamethoxazole. An algorithmic clinical approach and heightened public health measures may reduce rates of future SSTIs among basic trainees at Lackland Air Force Base.

Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are often categorized, according to where they were acquired, as community-associated (CA) or hospital-associated (HA). The most common sites of infection for CA-MRSA are the skin and the adjacent, subcutaneous soft tissues, although osteomyelitis, pneumonia, and other invasive forms may also occur.[1] In the absence of clinical infection, MRSA often colonizes the human body, typically in the anterior nares, with colonization rates estimated at 1.5 percent in the general U.S. population and 2-3 percent among military trainees.[2-4] The risk factors associated with CA-MRSA infection – trauma to the skin, close contact with infected or colonized persons, and shared sports equipment or hygiene products – cannot be used to distinguish MRSA from methicillin-sensitive *S. aureus* (MSSA).[5]

Along with incarceration in prison and participation in some competitive sports, military training is considered a high-risk setting for MRSA transmission.[6-7] A 2002 outbreak among Navy trainees in San Diego resulted in 34 incident skin infections within a 12-week period. In a post-outbreak survey, two risk factors for infection were identified: having a roommate with a prior skin infection (OR: 3.4; 95% CI: 1.3-8.9) and having a family member or friend who worked in a healthcare setting (OR: 2.8; 95% CI: 1.1-7.2).[3]

Among all active duty service members from 2005 to 2010, the estimated incidence rates of CA-MRSA and MSSA skin and soft tissue infections (SSTIs) were 281 and 166 per 100,000 person-years, respectively. Rates were higher in males than in females, and those aged 18-24 years had the highest rates. Among all TRICARE beneficiaries during this period, 62 percent of positive wound or abscess cultures grew *S. aureus* and 35 percent grew MRSA.[8] In a study of deployed military and civilian personnel assigned to Camp Liberty, Iraq, between March and July 2008, the incidence rate of CA-MRSA was 600 per 100,000 person-years. In this small sample of 26 cultured SSTIs, 85 percent (n=22) grew *S. aureus* and 58 percent (n=15) grew MRSA.[9]

This study describes the period prevalence of SSTIs among basic military trainees (BMTs) at Lackland Air Force Base (AFB), Texas, between 1 October 2008 and 30 September 2012, and demographic and clinical variables associated with such infections. Specific clinical and public health measures to reduce these infections in the future are discussed.

METHODS

Cases of SSTIs were ascertained from the Lackland AFB disease and non-battle injury database, which synthesizes diagnoses made in the electronic health record during all trainee medical encounters with demographic information from the BMT personnel file, including the unit and dormitory to which assigned. Air Force basic trainees are assigned 50 per dormitory room and share ten showers and ten sinks. The database was queried for International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), codes commonly associated with SSTI: 680.x (carbuncle and furuncle), 681.x (cellulitis and abscess of finger and toe), or 682.x (other cellulitis and abscess).[9] A trainee could be a case only once during the surveillance period of 1 October 2008 through 30 September 2012. In keeping with the training schedule, results were stratified by fiscal year (FY) rather than calendar year.

For the 501 cases identified by this query, retrospective electronic chart reviews were performed to determine wound location, treatment, and culture result, if collected. Cases that occurred after basic training (e.g., among technical trainees) and cases that were obviously miscoded (e.g., mosquito bite) were excluded.

TABLE 1. Skin and soft tissue infection (SSTI) counts among basic military trainees, Lackland Air Force Base, fiscal years (FY) 2009-2012

	FY09	FY10	FY11	FY12	FY09-12
Basic military trainees	38,211	36,645	36,223	37,276	148,355
Total SSTIs	52	40	54	143	289
Cultured cases					
Methicillin-resistant *S. aureus* (MRSA)	14	3	8	23	48
Methicillin-sensitive *S. aureus* (MSSA)	8	3	3	10	24
Other	0	1	0	1	2
Negative	2	2	2	7	13
Uncultured cases					
Possible MRSA SSTI	6	11	15	16	48
Simple SSTI	22	20	26	86	154

FIGURE 1. Wound culture results among basic military trainees, Lackland Air Force Base, fiscal years (FY) 2009-2012

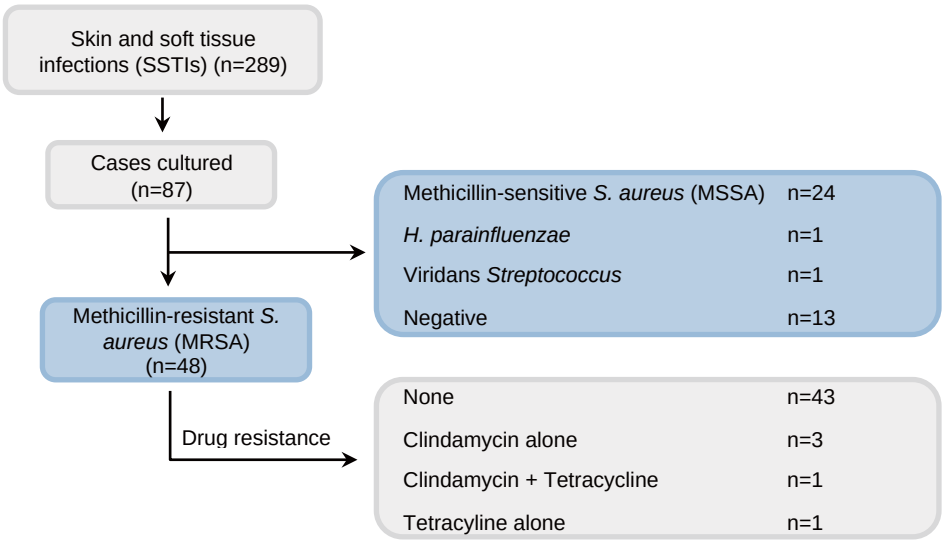
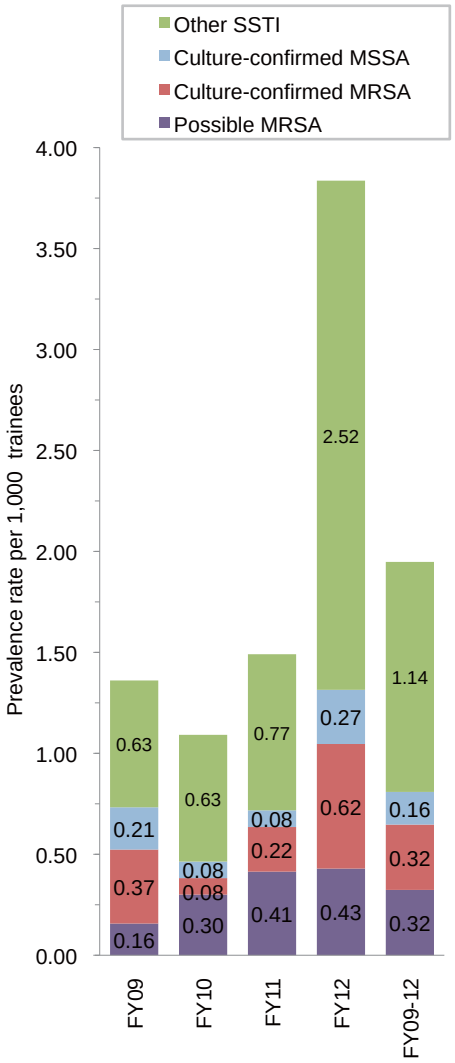


FIGURE 2. Skin and soft tissue infection (SSTI), methicillin-resistant *S. aureus* (MRSA), and methicillin-sensitive *S. aureus* (MSSA), period prevalence rates per 1,000 trainees, Lackland Air Force Base, fiscal years (FY) 2009-2012



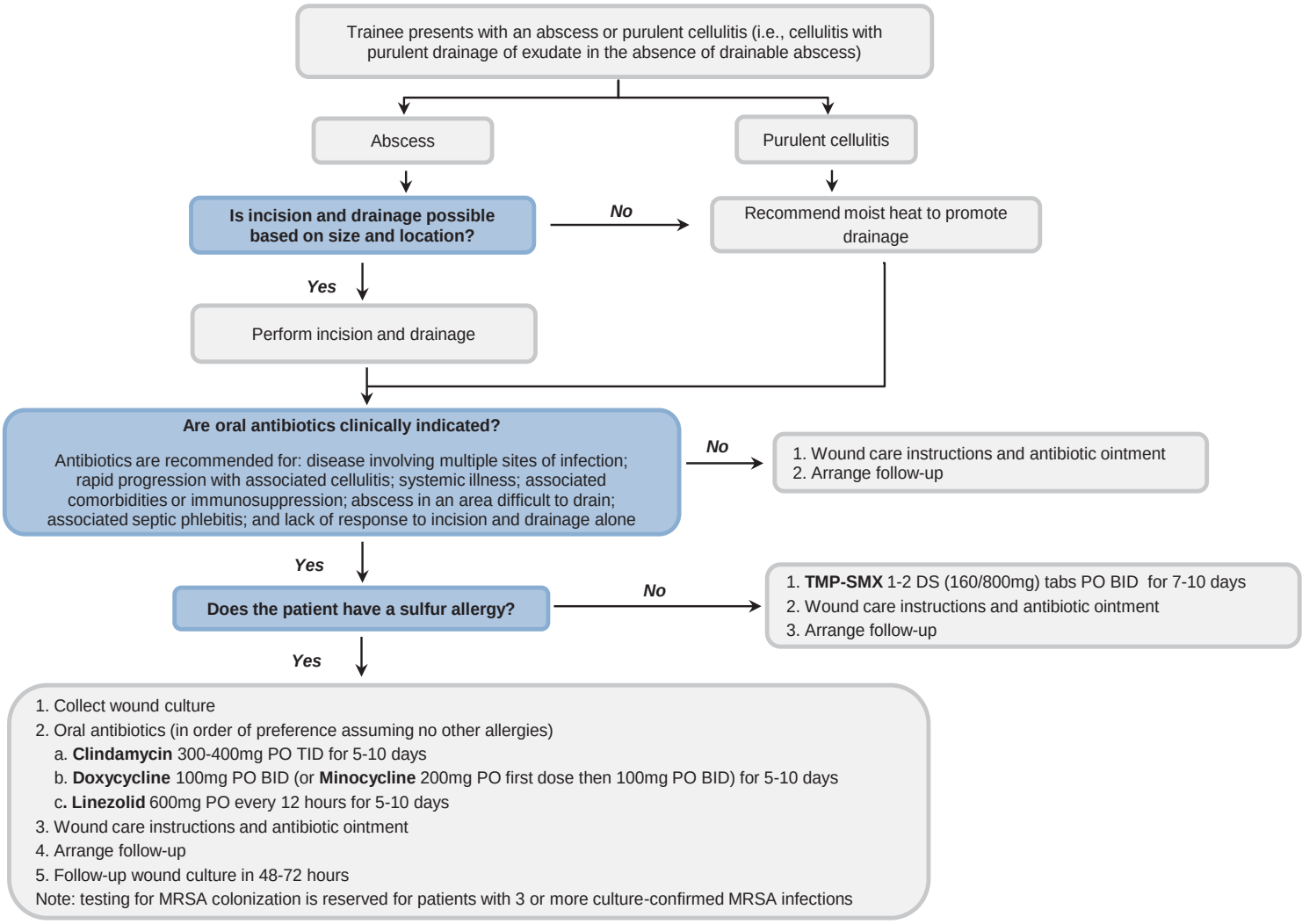
Included cases were stratified as either cultured or uncultured. Cultured cases were further stratified by organism, and MRSA and MSSA cases were compared using a number of variables. Uncultured cases were further stratified as either "simple SSTI" or "possible MRSA SSTI," defined as a case treated with both incision and drainage (I&D) and MRSA drug coverage (i.e., trimethoprim-sulfamethoxazole [TMP-SMX], clindamycin, a tetracycline, or linezolid).

For each of the case definitions, the period prevalence – where period is defined by the 8.5 week training session – was calculated using denominator data provided by the Lackland AFB Trainee Health Surveillance Epidemiology Office. Training sessions that spanned the end of one FY and the beginning of the next FY were counted in the FY during which the session began. It was assumed that all trainees completed exactly 8.5 weeks of training (i.e., no attrition and no prolonged training). All SSTIs were stratified by age, sex, training unit, week of training, wound location, oral antibiotic prescribed, and whether or not an I&D was performed.

Person-to-person transmissibility was assessed by investigation of every episode of at least two concurrent cases of MRSA or MSSA within the same training unit, where concurrent was defined as medical encounters within 14 days; both possible and culture-confirmed cases were considered MRSA cases for this analysis.

Statistical analyses included Student's t tests for continuous variables, χ^2 tests for categorical variables, and period prevalence ratios with 95 percent confidence intervals (CIs) to compare fiscal years. All analyses were performed with OpenEpi online software (http://www.openepi.com). p-values less than .05 were considered statistically significant; all p-values were based on 2-sided tests.

FIGURE 3. Algorithm for outpatient treatment of abscess/purulent cellulitis among Lackland Air Force Base basic trainees



Abbreviations: PO, by mouth; TID, three times a day; BID, two times a day; TMP-SMX, trimethoprim-sulfamethoxazole

RESULTS

Among the 148,355 BMTs at Lackland AFB between 1 October 2008 and 30 September 2012, there were 289 SSTIs identified by the query and chart review **(Table 1)**. Eighty-seven cases were cultured, and 85 percent of all cultures collected were positive. Of the 74 positive cultures, 72 (97%) grew *S. aureus* and 48 (65%) grew MRSA; the two other positive cultures grew *Haemophilus parainfluenzae* and viridans *Streptococcus*. Among all culture-confirmed MRSA cases (n=48), there were three cases of clindamycin resistance, one case of tetracycline resistance, and one case of dual clindamycin and tetracycline resistance **(Figure 1)**. No TMP-SMX resistance was identified.

The period prevalence rates of all SSTIs, possible MRSA SSTIs, and culture-confirmed MRSA and MSSA SSTIs increased annually since FY10, with a peak in all three categories in FY12 **(Figure 2)**. The 2012 prevalence of culture-confirmed MRSA cases was 7.5 times (95% CI, 2.3-25.1) the prevalence in FY10; the 2012 combined prevalence of possible and culture-confirmed MRSA cases was 2.7 times (95% CI, 1.5-5.0) that of 2010.

Among trainees with any SSTI, the average (SD) age was 21.5 (3.3) years, and 80 percent were male. SSTIs were spread throughout the training period, with a minor peak during week 2. The body locations of the infections were quite varied, with a slight predominance occurring on the buttocks, groin, or lower extremities (53% of total). When antibiotics were used, TMP-SMX was the drug of choice, followed by clindamycin, cephalexin, and doxycycline. I&D was performed in 101 (35%) of cases.

Among trainees with a possible or culture-confirmed MRSA SSTI, the average (SD) age was 22.3 (3.6) years, and 88

percent were male. Infections occurred in every week of the training period with 58 (60%) occurring between weeks 2 through 5. TMP-SMX was prescribed in 53 (55%) cases and clindamycin in 29 (30%). I&D was performed in 90 (94%) cases. Culture-confirmed MRSA and MSSA cases were similar by age (p=0.99), sex (p=0.83), and wound location (p=0.11). I&D was performed on a greater proportion of MRSA than MSSA abscesses (p=0.01).

During the surveillance period, there was only one instance in which two trainees who shared a dormitory had concurrent cases of possible or culture-confirmed MRSA. A third trainee in the dormitory was also diagnosed with an SSTI during the same week. There were no concurrent MSSA cases within a single dormitory.

EDITORIAL COMMENT

Rates of SSTIs, including possible and culture-confirmed MRSA cases and culture-confirmed MSSA cases, increased among BMTs at Lackland AFB between October 2008 and September 2012. Among positive wound cultures, 65 percent were MRSA, similar to the proportion among U.S. service members deployed to Iraq in 2008[9] and substantially higher than the proportion among all TRICARE beneficiaries from 2005 to 2010.[8]

This study has at least three limitations. First, since healthcare providers may treat SSTIs clinically, without performing a culture, it is likely that some cases classified here as possible were in fact MRSA. The results are presented by stratified case definition in order to account for this situation without overestimating the number of true positives. Second, the quality of data capture relies on ICD-9-CM codes, which may vary based on provider preference (e.g., an abscess coded as a "wound not otherwise specified" would not have been captured by the query). These ICD-9-CM codes, however, are fairly consistent with those used by other military and civilian studies.[9-11] Third, the period prevalence rates are based on the assumption that all trainees completed training in 8.5 weeks; in other words, no trainee dropped out and no trainee required additional time. Since approximately 94 percent of BMTs complete training in the 8.5 week interval, this assumption should not dramatically alter the results of this study. In addition to stratified case definitions, the primary strength of this study was the availability of treatment decisions and culture results within the electronic health record.

The findings in this study may trigger both clinical and public health responses. These data can be incorporated with 2011 clinical practice guidelines from the Infectious Diseases Society of America to develop an algorithmic approach to the outpatient treatment of SSTIs among Lackland BMTs **(Figure 3)**.[1] The high MRSA positivity rate in this population suggests that all abscesses should be treated as MRSA unless future microbiological surveillance suggests otherwise. While infrequent at 8 percent, the presence of clindamycin resistance indicates that TMP-SMX should be used as the first-line agent in non-allergic patients. Although clindamycin resistance was twice as common as doxycycline resistance, and although both are associated with photosensitivity, clindamycin is generally preferred given the more frequent and severe photosensitivity associated with doxycycline.[12] While I&D is the mainstay of therapy for abscesses, the use of empiric antibiotics may be added based on clinical indication. When an antibiotic other than TMP-SMX is used (e.g., for a trainee with a sulfur allergy), a wound culture should be collected and followed at 48-72 hours for organism identification and drug resistance. While the decision to provide antibiotic coverage of β-hemolytic streptococcus for an abscess is deferred to clinical judgment, the data do not support reflexive coverage in this population. Wound care instructions and topical antibiotics should be provided in all instances. Testing for MRSA colonization of the nares should be reserved for patients with ≥3 culture-positive MRSA cases. Lackland Trainee Health Surveillance should recall that the rate of culture-confirmed MRSA may continue to increase, even if the true rate remains unchanged, based on increased vigilance and culturing.

Given the close living and training arrangements, use of communal restrooms,[13] lack of time for personal hygiene, disruption of skin integrity by conditions such as blisters and abrasions,[14] warm ambient temperature,[10] and geographical location of the base,[8] BMTs at Lackland AFB are uniquely susceptible to SSTIs. It is incumbent upon the public health community to mitigate these risk factors and to disrupt bacteriologic niches without compromising the training mission. The epidemiologic triangle, or host-agent-environment model, can be helpful in identifying targets for intervention.

At the host level, steps to protect the skin barrier should be considered. Studies in Army Ranger training indicate that protective gear, such as knee pads, can reduce the risk of skin breakdown during repetitive activities.[15] Although MRSA cases in this population occurred throughout the 8.5 week training interval and were distributed throughout the body – and thus do not appear linked to any particular training activity – personal protective equipment such as gloves or shin guards may be used to prevent repetitive minor injuries, such as during the obstacle course. Personal hygiene is also paramount to skin integrity. In addition to the hygiene lecture during in-processing week, three messages should be emphasized throughout basic training: trainees should wash hands with soap and water several times daily; they should not share towels or hygiene products; and in the event of developing an abscess, even if attributed to an insect bite, they should not manipulate or squeeze the lesion. Training instructors should encourage and even enforce these basic messages. Alcohol-based hand sanitizers, though less effective, should also be used during field training.[14]

At the agent level, all wounds and abscesses should be promptly evaluated and treated according to the clinical algorithm provided above. When wound cultures are collected, providers should follow the results and rapidly modify the antibiotic regimen in cases of drug resistance. Wound care instructions, to include covering the wound and washing hands frequently, are equally essential to interrupt the transmission of *S. aureus* and other pathogenic bacteria.

At the environmental level, shared surfaces and equipment, such as pugil sticks and gas masks, should continue to be

cleaned between uses with an anti-staphylococcal agent, such as 1:10 bleach solution.[14] Razors and other personal hygiene products should not be shared under any circumstances.

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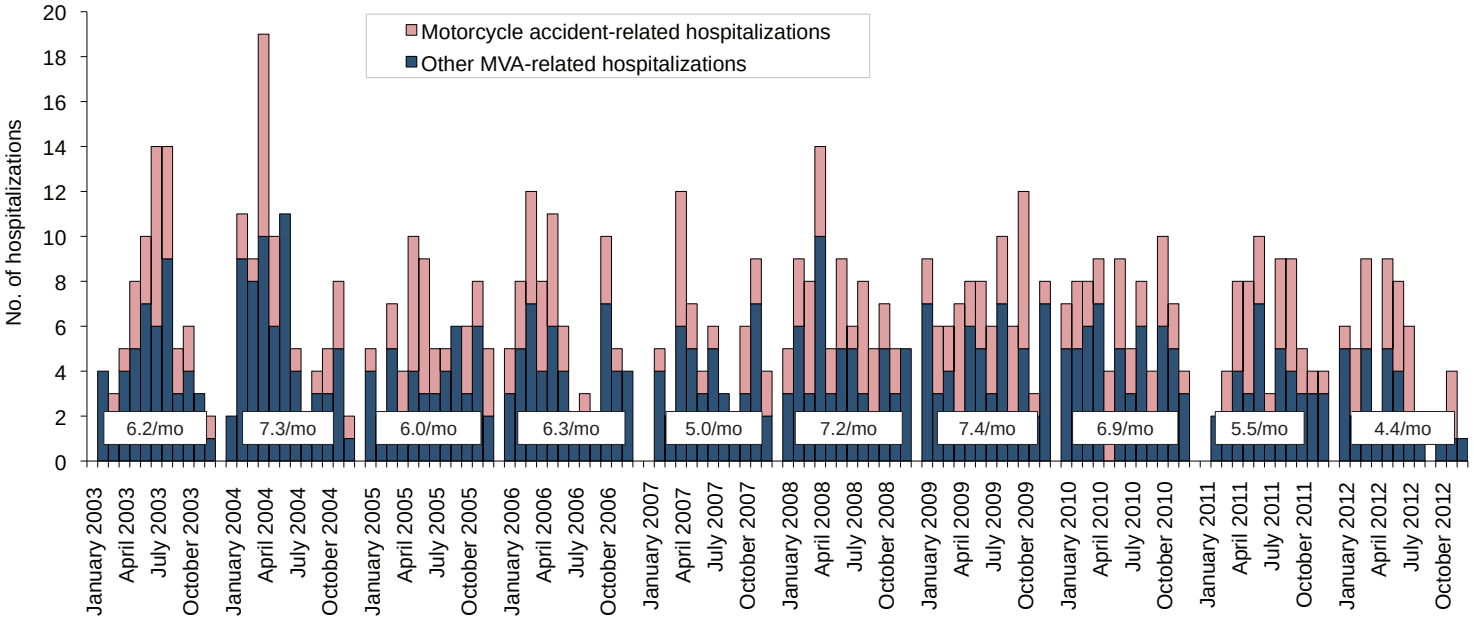
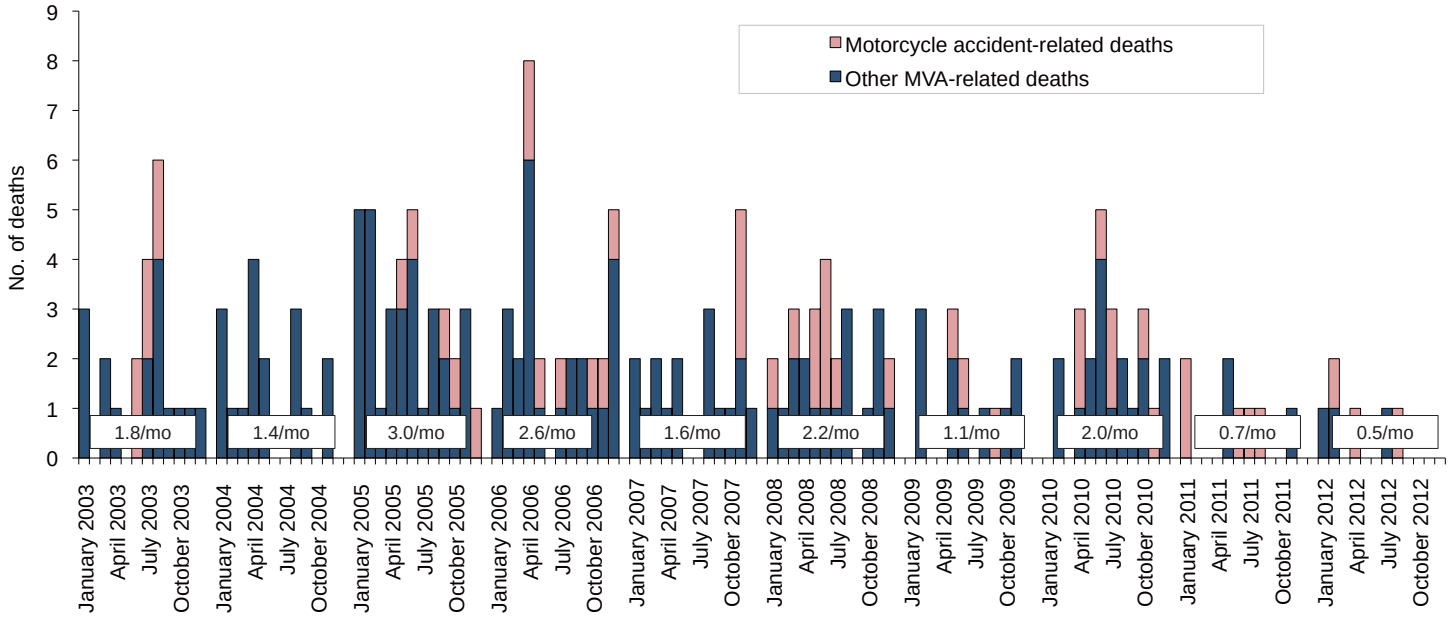
Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-December 2012 (data as of 22 January 2013)

Hospitalizations outside of the operational theater for motor vehicle accidents occurring in non-military vehicles (ICD-9-CM: E810-E825; NATO Standard Agreement 2050 (STANAG): 100-106, 107-109, 120-126, 127-129)



Note: Hospitalization (one per individual) while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days of another motor vehicle accident-related hospitalization.

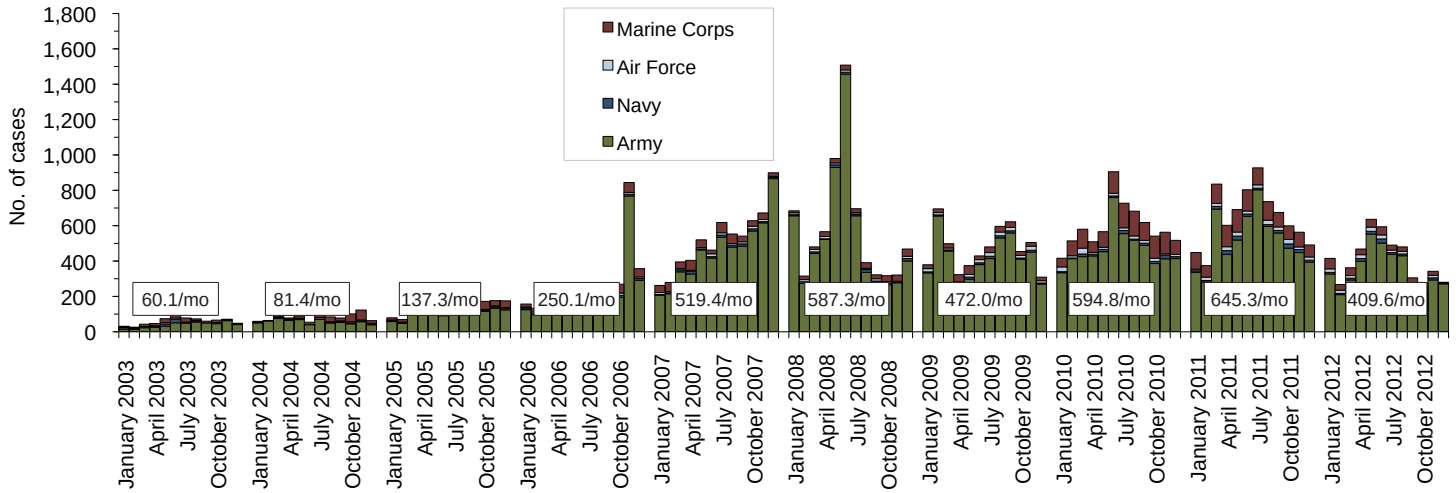
Deaths following motor vehicle accidents occurring in non-military vehicles and outside of the operational theater (per the DoD Medical Mortality Registry)



Reference: Armed Forces Health Surveillance Center. Motor vehicle-related deaths, U.S. Armed Forces, 2010. Medical Surveillance Monthly Report (*MSMR*). Mar 11;17(3):2-6.
Note: Death while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days prior to death.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-December 2012 (data as of 22 January 2013)

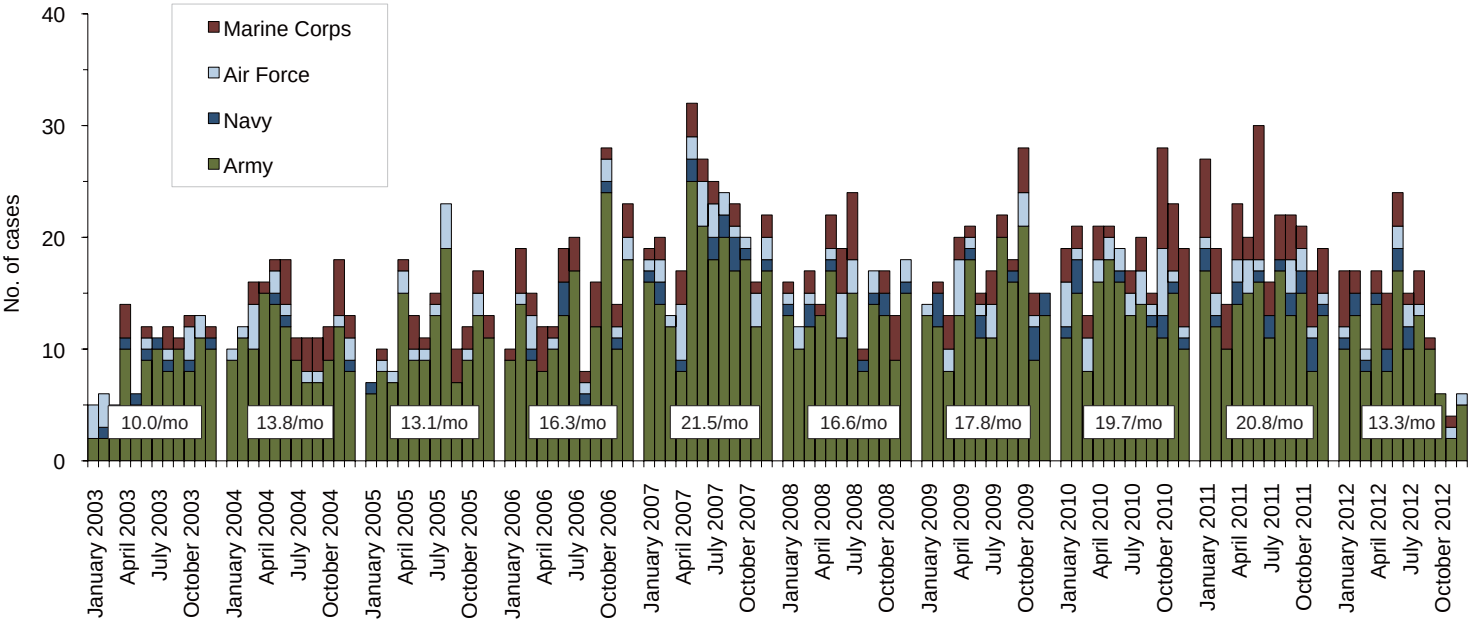
Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.52_0-9, V15.52_A-F, V15.59_1-9, V15.59_A-F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 4,108 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]

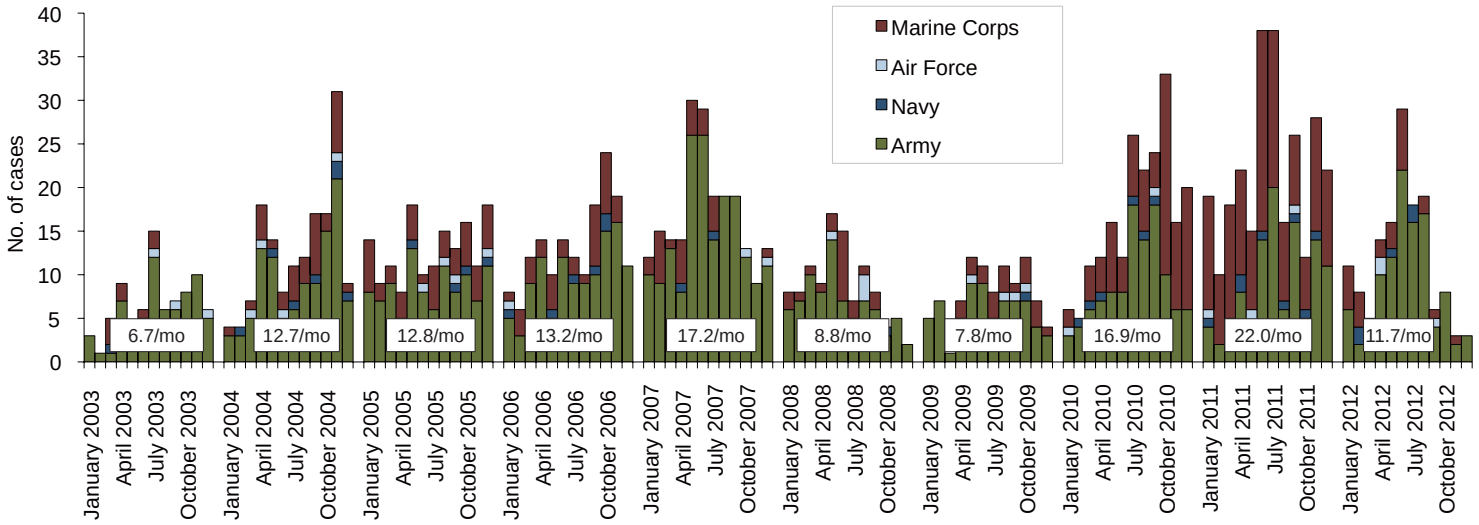


Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379-83.

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from OEF/OIF.

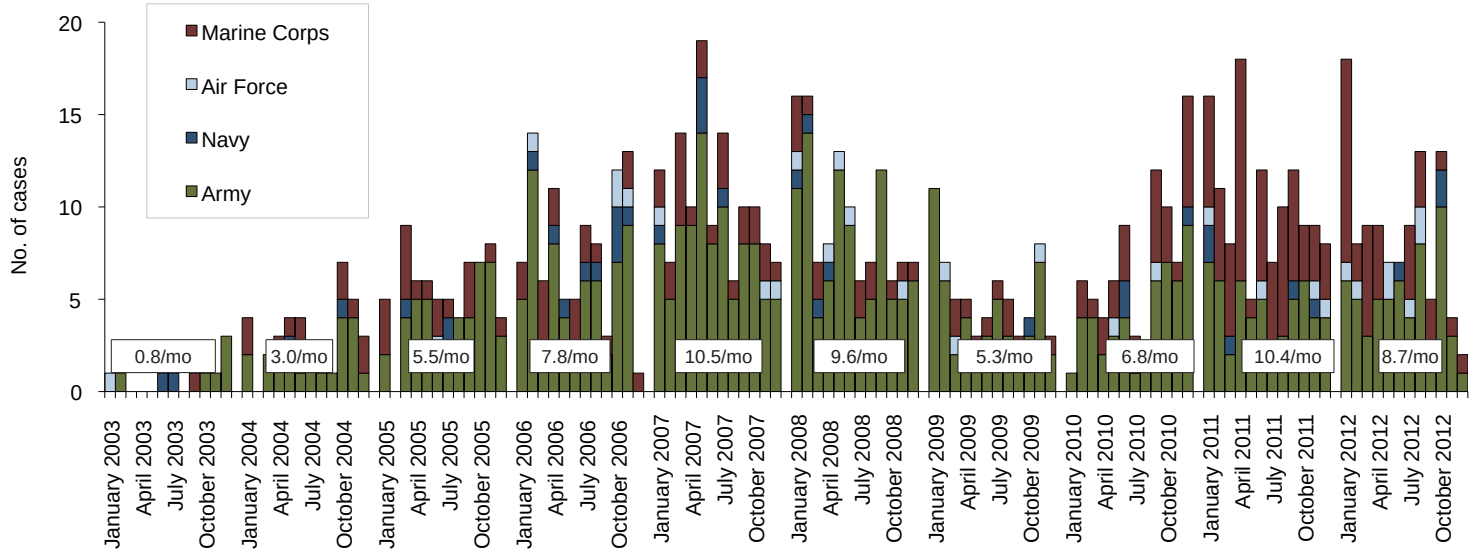
Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003-December 2012 (data as of 22 January 2013)

Amputations (ICD-9-CM: 887, 896, 897, V49.6 except V49.61-V49.62, V49.7 except V49.71-V49.72, PR 84.0-PR 84.1, except PR 84.01-PR 84.02 and PR 84.11)[a]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990-2004. *MSMR*. Jan 2005;11(1):2-6.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from OEF/OIF/OND.

Heterotopic ossification (ICD-9: 728.12, 728.13, 728.19)[b]



Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002-2007. *MSMR*. Aug 2007; 14(5):7-9.
[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from OEF/OIF/OND.

Medical Surveillance Monthly Report (MSMR)
Armed Forces Health Surveillance Center
11800 Tech Road, Suite 220 (MCAF-CS)
Silver Spring, MD 20904

THE MEDICAL SURVEILLANCE MONTHLY REPORT (MSMR), in continuous publication since 1995, is produced by the Armed Forces Health Surveillance Center (AFHSC). The *MSMR* provides evidence-based estimates of the incidence, distribution, impact and trends of illness and injuries among United States military members and associated populations. Most reports in the *MSMR* are based on summaries of medical administrative data that are routinely provided to the AFHSC and integrated into the Defense Medical Surveillance System for health surveillance purposes.

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ISSN 2158-0111 (print)
ISSN 2152-8217 (online)